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Review of the Food Guidelines in Continuous Ultramarathon

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Abstract

The ultramarathon is defined as an event whose distance is greater than a marathon. It requires not only a preparation on the endurance performance, but also of other more specific qualities such as orientation and climbing. This type of event has a minimum duration of 5 h up to 22 consecutive days or more. These characteristics influence in the preponderance of the energy system and consequently which nutrients will be necessary to intake and increase in order to replace them.

The adequate nutritional planning is a fundamental tool to optimize the athlete's performance, replenishing nutrients and electrolytes and reducing fatigue during exercise

The aim of the review is to determine dietary guidelines in continuous ultramarathons. The energy, macronutrient, vitamin, and mineral requirements will be increased according to the intensity and duration of the ultramarathon. The energy expenditure ranges from 350-650 kcal/h, determining a negative balance. The role of carbohydrates for its rapid energy replenishment and the role of lipids for multi-day events are distinguished. The recommendation of carbohydrates is 7-12 g/kg in order to achieve muscle glycogen repletion. Protein intake is 1.2-1.7 g/kg to prevent muscle damage and/or used it as an energy source in case of a poor energy supply. Hydration is crucial in prolonged events and especially in warm environments.

Once the systematic review of nutritional guidelines in continuous ultra-marathon events has been performed, it has been found that athletes fail to meet nutritional and water recommendations. The cause of this fact is multifactorial (e.g., high energy depletions, inability to carry the totality of food with them, tiredness of the same flavors, hot environmental conditions..), but mainly due to gastrointestinal discomfort and lack of appetite. It is important to provide runners with not only accurate nutritional guidelines, but the correct way to accomplish them to finish the event and to prevent episodes that compromise their health.

Keywords: Nutrition in ultramarathon; Hydration in heat ultra-marathon; Fluid in ultramarathon

Introduction

Defines the marathon as any endurance race that covers a distance of 42,195 km [1] and that the ultra-marathon that exceed this distance. Most of them are carried out in mountains, mountain ranges, uneven terrain requiring a training combining knowledge such as hiking, trekking, climbing, orientation and distances. The complexity of these events stems from the wide variety of geographical and climatic conditions [2].

These events can be continuous or multiple days, as well as presented with individual category or team where members must remain together. The aim is to cross the finish line, with various control points that also act as support for athletic stations since there are supplied food, hydration, and medical care and health services.

Modern Ultra marathon (UM) events were initiated in early 1980 when New Zealand hosted the so-called «Coast to Coast» and in Alaska in 1983 the Wildeness Classic [3]. In recent years these events have become popular, with an obvious and growing number of beginners.

The characteristics of the ultramarathoners, dominated by men, tend to start in marathons [1] and reach their best performance among the 30 to 49 years for men and 30 to 54 years for women; There are differences between runners and the ultra-marathoners to compare [1] anthropometric characteristics, age and training in age, the upper arm, and the circumference of the thigh and the thickness of skin folds in the breastplate, axillary and suprailiaco. Several studies [1] also distinguished the relationship between anthropometric characteristics and prediction in the performance of the Ultramarathon (UM) and concluded that the training is more relevant than the anthropometric characteristics that are priority in distances up to the half marathon.

Although the performance improves with training [4], there are different features physiological, anthropometric, economics, race, composition of fibers, aerobic capacity and type of training that are predictive for determine how to perform UM.

Also discussed if performance decreases in heat [5] and found some performance reduction as it increases the environmental heat stress [6].

Performance in heat reduction is in part to dehydration due to loss of sweat, with negative consequences for the cardiovascular capacity and thermoregulatory function [7]. The effects of hypohydration on physiological function and performance of the exercise also are far greater when exercise takes place in the heat that is imposed when the same level of hypohydration cold [8]. A deficit of fluid before exercising just a 1.5-2.0% of the body mass showed that causes substantial loss of

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performance in both the events of 4 to 30 minutes race but is greater (approximately 6-7% on average) in the major events duration.

Another factor to consider is that the athlete requires a higher energy intake and an increase in the micro-nutrients and that the power of the athlete should serve for the health of it (American Dietetic Association - ADA-, Dietitians of Canada - DC - and) American College of Sports Medicine - ACSM-2009; International Olympic Committee - IOC-, 2004). There are two fundamental aspects: the particular characteristics of each athlete and the type of ultramarathon adventure.

Feeding will allow to develop Burke (2007) described functions which are: preventive function (planning intakes depending on the distance and the climatic conditions for that with the correct contribution of macronutrients and micronutrients are avoided deficit states of energy, vitamins or minerals, disorders in body thermoregulation and, therefore, the decrease in performance or production of sports injuries. The function of performance, with inputs of nutrients to improve training or competition, with drinks sports, rich in carbohydrates and minerals, in long-lasting activities, where the depletion of energy substrates and the Osmotic imbalance constrain performance. Finally, the role of treatment, the specific contributions of nutrients may play a role in which fundamental right to a deficiency state, as sports anemia or disorders in the woman's menstrual cycle, or a more or less severe of chronic fatigue or lesions. Therefore, an adequate food will ensure an optimal precondition for carrying out physical effort with certain intensity and/or duration. Also try to balance the electrolyte loss and energy during physical exercise, through the exogenous supply of nutrients right at the start and along the same, helping preserve muscle glycogen in continuous and prolonged efforts. And finally, a proper power supply ensures a fast and efficient replacement of energy substrates diminishes during exercise and power anabolic processes that allow a correct recovery for new training sessions or competition in best conditions [2,9].

On the other hand, require different works of strength, power, speed, technique, strength, eating properly designed will help athletes train with greater intensity, reduce the risk of illness or injury and get good results [9-11].

Energy needs vary according to sex, age, weight and body composition, but the most important factors and determinants of energy expenditure are the type, intensity, frequency and duration of physical activity carried out, the degree of training, the physical condition, prior to the diet, and weather conditions. The relative contribution of the macronutrients (carbohydrates, fats and proteins) to the total energy expenditure will vary depending upon these factors [10] as well as the body energy reserves carbohydrate and fats are adequate to meet the demand of power of most of the activities for at least one hour. They are not considered proteins as a source of significant energy during exercise. The content of vitamins and minerals from the body should also be sufficient to help regulate the metabolic activity levels increase and the body water supply will be adequate under normal environmental conditions.

Caloric intake must be optimal to achieve good performance in a UM and avoid fatigue, weight loss, inability to continue the event, etc. [12]. In daily practice the athletes employ body monitors to estimate caloric expenditure to thus set nutritional strategies and the consumption of oxygen to determine the energy cost of the activity [13].

ACSM (2016) set as reference value 45 kcal/kg mass free fat per day associated with a healthy and optimal energy balance. specific studies in Ultramarathon and [14] or the [15] established 4-6 kcal/kg/h. [16-18] were measured by indirect calorimetry and doubly labeled water energy expenditure at the Western States Endurance Run (WSER), it was 13000-16000 kcal. Applegate (1991) sets the calculation of calories whereas the energy expenditure of 47.76-71.65 kal/km. To prevent a complication more common such as lack of appetite this makes it difficult to comply with the high caloric intakes [13]. Indeed, the energy requirement depends on the age, gender, body composition, type of sport, the duration and intensity of the same (ACSM, 2016) [12,13].

The consumption of carbohydrates in the athlete nutrition plan (both in the pre, during and post-competition), as well as the analysis of the metabolism of muscle glycogen during exercise, the effects of intensity and exercise on deposits energy [16-20], such as the need for proteins, fats, vitamins and minerals are as important as the General guidelines of hydration (even in warm environments) are essential to prevent gastrointestinal upset. The objective of this review is to describe the different nutritional strategies employed by ultramarathon runners continued with an interest in the intake carbohydrate. Specific objectives are determining the anthropometric characteristics of the corridors of UM and describing hydration in events held under hot environmental conditions.

Materials and Methods

Articles sought for this review were those of the databases MEDLINE, Pubmed, Scopus, and Google Scholar with the following keywords: «Nutrition in Ultramarathon», «Fluid in ultramarathon», «Nutrition in heat ultramarathon».

Inclusion criteria: articles concerning ongoing competitions; exclusion criteria those items that were not events of UM (greater than 42.2 km distance), does not include nutritional variables/hydration in UM racing, who mention antioxidants, vitamins, the associated medical complications during the UM or mention hyponatremia or established information about the subjects. The final sample of the review study was 15 items (Figures 1 and 2).

Procedure

The review has arranged sections which enable you to determine the intake of carbohydrates and fluids. It will proceed to explain the characteristics of an Ultramarathon and the type of athletes who attend it, as well as energy requirements, carbohydrates, proteins, lipids, and hydration. At the end of tables summary with more detailed information on used items are included.

Characteristics of the ultramarathon

The continuous ultramarathons analyzed the most mentioned is the Western States Endurance Run with a 35% (6 articles) and most popular relevant between the UM is the Badwater Ultramarathon Race with just one article [2]. Most of the UM analyzed corresponded to environmental conditions of high thermal amplitude.

Features of subjects

Sample size: going from 658 athletes (Hoffman et al.) to an athlete (Moran et al.) [21,22].

Age: in the majority of studies runners age ranges between 40 and 48 years. There are exceptions with ages as minimum of 25 (Moran et al.) 35 (Stellingwerff et al.) and maximum 54 years [2,11,22].

Genre: mostly male runners, but stands a single study only with a woman [22].

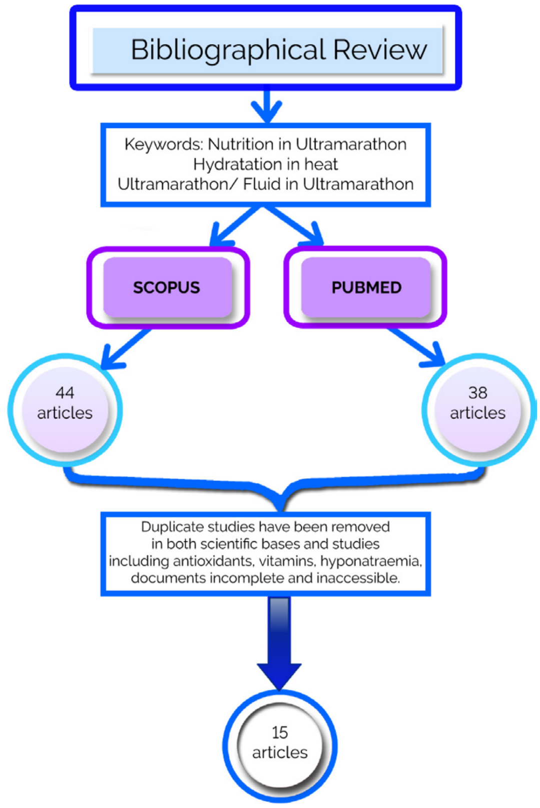

Figure 1: Procedure for scientific papers for the review of the literature.

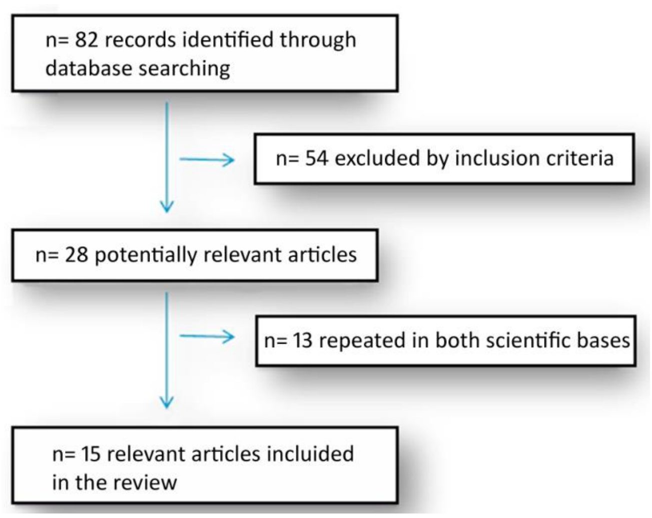

Figure 2: Diagram flow.

Body fat percentage: An article provides the percentages of body fat, which are 14.6% [23]. These values are the optimum whereas article of Barnard et al. with an average percentage for runners of long distances of 18.0 ± 1.1% [24]. Similarly, Hoffman et al. sets the parameters for the percentage of fat are 17 ± 5 (range 5-35) for men and 21 ± 6 (range 10-29) for women [21].

Previous experiences in UM: except for a study (Moran et al.) in the rest of the articles runners had vast experience at UM events, some of which had won several previous events (O'Hara, 1977) or those described in their own study (Stellingwerff et al.). In the case of the exception, it is important to emphasize that the runner had experience in Olympic distance, Triathlon, Marathon [11,21,22,25].

Weekly training: in several articles the training was recorded around the weekly kilometers. The maximum amount of weekly miles corresponding to the study of Stellingwerff et al. with only 173 km and minimum of 85.3 km [21,26].

Mode in which the subjects were recruited: for observational studies, some items did not specify how recruited subjects [21,27-29]. Wardenaar et al. employed a mail to recruit through the Organization of the event with specific criteria such as be preparing to the event in question, be between 16-70 years, as well as speak and understand German [30]. For his part, Glace et al. recruited via a letter 3 months prior to the event [31]. In the case studies, subjects were veterans of elite athletes [21], experienced and with record tape Ergometer [13].

Types of studies

The items found were of two types: (Table 1). You can see that 24 articles, only 4 are case studies [2,11,22,26].

Measurement protocols

The protocols will be divided into two:

Measurement of body variables: in articles all body weight was measured the day before (Glace et al.) or hours prior to the event. As a consequence of the duration, measurements were repeated in some kilometers. In an event [22] there is access at the first two checkpoints on the characteristics of the terrain. The weighing was performed in all cases with clothing and footwear, removing jackets, backpacks or belts. Glace et al. and Costa et al. employed in its analysis all of the variables (body weight, blood, urine sample, and anthropometric analysis) [31,29]. Hoffman et al. analyzed 3 variables: body weight and urine sample [29,31,32]. The third variable changes for Glace et al. anthropometric and the other two shows of blood [31]. On the contrary, Newmark et al. and Fallon et al. presented at least 2 variables, the rest of the articles just one, mostly body weight (Table 2) [26,33].

Reference	Type of studies
Newmark. 1991	2
Fallon et al. 1998	1
Glace et al. 2002 (a)	2
Glace et al. 2002 (b)	2
Clark et al. 2005	2
Moran et al. 2011	1
Stuempfle et al. 2011	2
Costa et al. 2014	2
Hoffman et al. 2014	2
Brown et al. 2015	1
VanBaak et al. 2015	2
Taylor et al. 2015	2
Wardenaar et al. 2015	2
Stellingwerff. 2016	1
Martínez et al. 2017	2

1: Case Study

2. Observational

Table 1: Type of study per item.

References	Body Weight	Bood Sample	Urine Sample	% Body Fat
Newmark et al. 1991	✚	✚	✚	✚
Fallon et al. 1998	✚	✚		
Glace et al. 2002 (a)	✚	✚		✚
Glace et al. 2002 (b)	✚	✚	✚	✚
Clark et al. 2005	✚		✚	
Stuempfle, Hoffman et al. 2011	✚			
Costa et al. 2014	✚	✚	✚	✚
Hoffman et al. 2014	✚			
Taylor, Stuempfle, Kern & Hoffman. 2015	✚			
Brown. 2015	✚			
Hoffman, Khodaee, Spittler & Van Baak. 2015	✚	✚	✚	
Wardenaar et al. 2015	✚		✚	✚
Stellingwerff. 2016	✚			

Table 2: Measurement of body variables by references.

Food data collection: This protocol shows greater discrepancy between articles: in some cases, there were, one week before Stuempfle et al. and finally the record of 12 hours prior to the event [26,31,34].

Food information was provided in two ways, or by reminder 24 h as in studies of, Hoffman et al. or by registration of food only used by Fallon et al. [26,34].

In other studies of [11,28,30,34] were developed questionnaires detailing the food that would consume during the event. In all cases the questionnaire highlighted food or hydration depending on the object of study by the researchers. Only one articles Stuempfle et al. mentioned the order made the athletes keep wrappers to check the nutritional information [34].

In studies of Fallon et al. and Costa et al. athletes support team was in charge of registering food [26,29]. Moreover, in studies of Stuempfle et al. and Moran et al. the work was performed by nutritionists. The other articles did not provide that information [35].

Results and Discussion

Assessment of the methodological quality

The analysis of all items, not only those corresponding to the object of study of the review because of the importance of the authors in this area of study, was performed.

For the total of items of UM continuous the number of citations whereas the following scientific bases were analyzed: Web of Science, Scopus, Google Scholar (Table 3). Most cited articles in the Web of Science, Scopus and Google Scholar are the same: [23,29,31]. In all cases the maximum amount of mention for article was done by the Google Scholar database due to their wider dissemination and inclusion of journals from different sources.

Violet color corresponds to the greatest number of citations and the Orange to the minor. The analysis determined that the greatest number corresponds to [23] with 189 quotations in total, followed by [29] and [23,31] with 139 and 126, respectively. Minor mention were [2,11,36] and those who did not have were [37,38] (the latter due to his recent publication). These results have shown that the most relevant scientific works are [23,29,31]. With respect to items of hydration in UM authors with the largest number of publications in Web of Science are Hoffman, Suempfle and Noakes, which were included in the review that occurs (Figure 3A).

Regarding the major publication in Scopus, are Hoffman, Stuempfle and Hew-Butler, the first two included in this review [21,34,35] (Figure 3B).

Energy requirement

Articles that include information on energy requirements are 10 (Tables 4-7).

Rontoyannis et al. established the recommendation between 10 kcal/Km [39]; Burke et al. highlights the need for an adequate energy intake to optimize the storage of glycogen [40]. Whereas the UM of 160 km, the higher energy requirement is (Table 8) Glace et al. followed by Stellingwerff [11,23]. With the lower requirements articles are for those who have not completed the 160 km and the Newmark (1991) at 100 km [11,33]. Stuempfle et al. calculated around 13000-16000 energy expenditure through the method of indirect calorimetry, but culminating UM consumed 8200 kcal (51-63% of the generated calorie expenditure) [35]. Several studies confirm the energy deficit [23], in this case was 38.45 kcal/km or 33.6% less calories consumed total expenditure [2]. It highlights the difficulty in establishing a specific caloric intake, anthropometric differences, topography and environmental conditions. Those who finished maintained a range around 3.2-7.6 kcal/kg/h while those that did not were placed below the recommendation and the group that ended it. To compare the average number of calories consumed in the article of [35] with other UM continuous these were similar (4.6 kcal/kg/h) with respect to the de [31,23] (3.3 kcal/kg/h and 4.0 kcal/kg/h). The differences appear on the UM in laboratory [38] with lower values (3.1 kcal/kg/h) or with regard to article [25] with higher values (7.8 kcal/kg/HR) to [35].

References	Web of Science	Scopus	Academic Google	Totals
Newmark. 1991	2	4	3	9
Fallon et al. 1998	34	42	63	139
Glace et al. 2002 (a)	36	34	56	126
Glace et al. 2002 (b)	46	51	92	189
Clark et al. 2005	6	6	12	24
Moran et al. 2011	7	7	10	24
Stuempfle et al. 2011	19	22	29	70
Costa et al. 2014		3	19	22
Hoffman et al. 2014	16	16	23	55
Brown et al. 2015			2	2
VanBaak et al. 2015			2	2
Taylor et al. 2015	0	0	2	2
Wardenaar et al. 2015	4	4	5	13
Stellingwerff. 2016	1	0	1	2
Martinez et al. 2017	0	0	0	0

not available
greater mention
minor mention

Table 3: Number of citations by author by scientific bases.

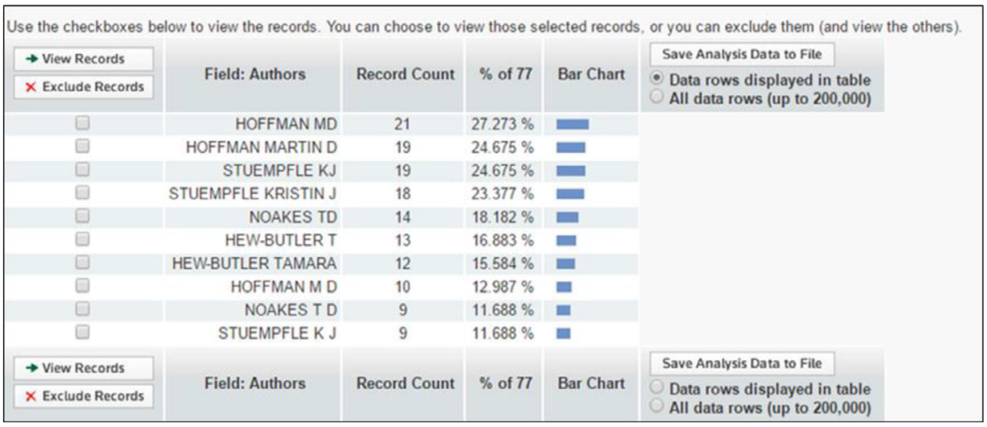

Figure 3A: Number of citations.

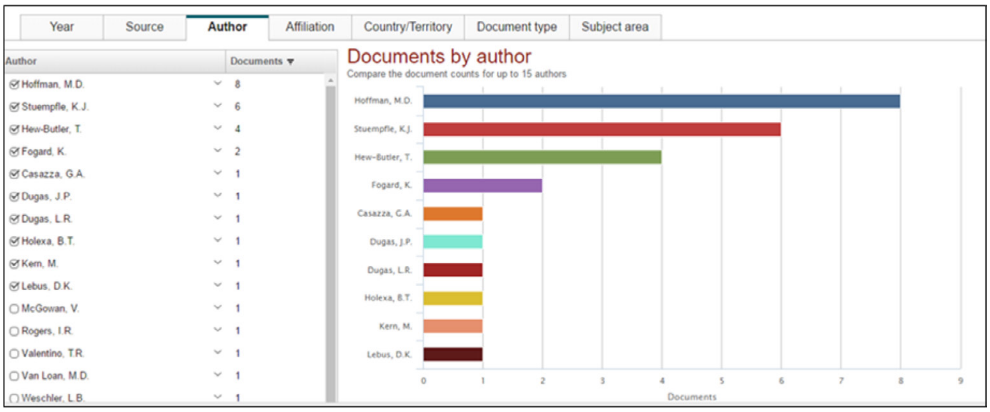

Figure 3B: Number of citations.

Reference	n	Distance (km)	Duration	RECOMMENDATION CALORIES	Calories Consumed	
					Totals Calories	Kcal/h
Newmark. 1991	3	100 y 160			1000 -4015	55
Fallon et al. 1998	7	100	10 h:48 min		1011	100
Glace et al. 2002 (a)	26	160	26.2		2268 ± 831	230
Glace et al. 2002 (b)	19	160	26.2		6047	33.5± 3.7 &
Clark et al. 2005	58		36			11.42-36.94 kj
Moran et al. 2011	1		12:48:55		2602	10.890 kj/h
Stuempfle et al. (2011)	6	161	27	4-6 kcal/kg BM/hour	5498– 11185	196.5– 444.2
	10			o 200 kcal/hour	902–5057	54.7–335.3
Costa et al. 2014	slow	< 160	24			
	fast	160	24			
Brown et al. 2015	4	217	34:05:25-40:51:46		8036,5	
Wardenaar et al. 2015	54	120	09:30:39		2700	
	14				2105	
Stellingwerff. 2016	3	160			5530	333
Martínez et al. 2017	51	112	17.5 ± 2.8 h		3041 ± 1594	174 ± 95.1

Table 4: Energy consumption v/s recommendation.

Carbohydrates

The intensity, duration and food intake will determine greatly the amount of fuel obtained from HCO, proteins and fats. Clark et al. reported the HCO is considered as the fuel most relevant for this type of event, and given that glycogen stores are limited, it is necessary that athletes perform intakes of them to maintain blood glucose levels [27,35]. Both authors stress the importance of raise nutritional strategies focused on your intake. On the other hand Jeukendrup et al. refers to the HCO as indispensable to improve performance [40].

Burke et al. established the recommendation to 90 g/h when the activity exceeds two hours 30 minutes; as well as the adequate proportion of 2:1, glucose / fructose [2,28,40]. In this review only in some studies [35,11] such values, it reached the remainder is less than the 60 g/h range. In the category of slower runners [28] is the lowest average (31 g/h) (Table 6).

Reference	n	Distance (km)	Duratión	Grams / hour	Totals Grams	%
Fallon et al. 1998	7	100	10:48	0,08 g/kg BM/h	13.8	7
Glace et al. 2002 (a)	26	160	26:20:00		128 ± 56	
Glace et al. 2002 (b)	19	160	26:20:00		0.48 ± 0.06	
Clark et al. 2005	58		36		0.03 ±0.2 °	6.2 ± 2.5
Stuempfle et al. 2011	6	161	27		10,7- 228	0.1 ± 11.1
	10				0- 188.8	0.0 ± 21.4
Costa et al. 2014	slow	< 160	24		93	
	fast	160	24		83	
Wardenaar et al. 2015	54 M	120	09:30:39		93.9 ± 23.2	
	14 F				72.5 ± 2.13	
Martínez et al. 2017	51	112	17.5 ± 2.8 h		51.4± 41.6	6.38± 3.05

Table 5: Protein consumed v/s recommendation.

Reference	n	Distance (km)	Duration	RECOMEMENDATION %	FAT	
					Totals grams	%
Fallon et al. 1998	7	100	10:48	25-30	9.7	5
Glace et al. 2002 (a)	26	160	26:20:00		137 ± 75	
Glace et al. 2002 (b)	19	160	26:20:00		0.47 ± 0.08 °	
Clark et al. 2005	58		36		0.03-0.28 °	
Stuempfle et al. (2011)	6	161	27		11.7–148.3	1.1-23.8
	10				19.4 ± 21.1	0.0–17.4
Costa et al. 2014	slow	< 160	24		115	
	fast	160	24		117	
Wardenaar et al. 2015	54 M	120	09:30:39		97.1 ± 39.8	31 ± 8.8
	14 F				76.1 ± 26.6	32.1 ± 8.3
Martínez et al. 2017	51	112	17.5 ± 2.8 h		77.4± 61	21.4± 11.7

Table 6: Fats consumed v/s recommendation.

Reference	n	Total (l)	RECOMMENDATION	Ratio ml/h	RECOMMNEDATION	% Change of BM
Newmark. 1991	3	4-22	400- 800 ml/h	800-1200	< 2% BM	-0.45*,- 0,68*,-0.45*
Fallon et al. 1998	7	5.7		540		-3.3*
Glace et al. 2002 (a)	26	11.9 a 28.1		700		-0.5 ± 1.5*
Glace et al. 2002 (b)	19	18		103.5± 5.7 &		-1.5 *
Clark et al. 2005	58			< 500		
Moran et al. 2011	1	6150 (3850 Gatorade)				
Stuempfle et al. 2011	6	8.3–25.9		278.4–978.4		−3.0 ± 1.9
	10 not completed	3.7–19.6		222.3–858.7		−3.0 ± 1.7
Costa et al. 2014	slow	7-5		316		
	fast	10-8		448		
Brown et al. 2015	4	33,8				
Wardenaar et al. 2015	54 M	2.9 ° ± 0.9				
	14 F	2.8 ° ± 1.2				
Stellingwer. 2016	3					
Martínez et al. 2017	51	6319 ± 4214		351.6 ± 239		

Table 7: Consumed hydration and % change of weight v/s recommendation.

In addition, Jeukendrup et al. refers to multiple sources of HCO intake to increase the highest rate of absorption [10]. These HCO with multiple conveyors derived in less gastrointestinal discomfort, reducing fatigue and allowing an improvement in performance. The same article mentions that absorption must be independent of the body weight of the subject. In some articles [11,27,30] establish if the ratio g/kg weight/h. Burke (2011) concerns the medium to high glycemic index for the HCO employed in the event or during the training (Table 8) [2].

The percentages of the intakes include a minimum of 72.2% [35,38] and a maximum between 98.4-100% [35]. These percentages in the composition of the diet were similar in several articles [23,26,31].

With respect to the type of foods like [22,40] refers to the importance of varying textures to prevent depletion of the flavor. Some runners showed a better tolerance to solid foods, compared to athletes who trained at greater intensity and shorter distances [23]. Several articles [22,23,26,35,38,39] highlight the preponderance of solid foods. Others preferred a sports drink [33,27]. The type of intake during workouts, was characterized by small volumes at higher frequency, in some studies was kept such a pattern [38].

For his part, [28] referred to the disparity between recommended and actual intakes. This last mentioned the limited amount of observational studies and how most of them were performed in well-trained individuals.

Reference	n	Distance (km)	Duration	RECOMMENDATION Grams HCO/ hours	HCO		
					Totals Grams	%	Ratio g/h
Fallon et al. 1998	7	100	10:48	90	223	88	42.8
Glace et al. 2002 (a)	26	160	26:20:00		1419 ± 622	81	
Glace et al. 2002 (b)	19	160	26:20:00				6.8 ± 0.62 g/kg/h
Clark et al. 2005	58		36		754	24.7 -79.3	0.53- 1.76 g/kg/h
Moran et al. 2011	1		12:48:55		558		44
Stuempfle et al. (2011)	6	161	27		999.1–2367	71.1–98.4	36.0–102.1
	10				227–1257	71.3–100	13.8–83.8
Costa et al. 2014	slow	< 160	24		496		31
	fast	160	24		1048		44
Brown et al. 2015	4	217	34:05:25-40:51:46				
Wardenaar et al. 2015	54 M	120	09:30:39		327		4.4 g/kg
	14 F				258		4.5 g /kg
Stellingwerff. 2016	3	160			1162		71
Martínez et al. 2017	51	112	17.5 ± 2.8 h		534.9 ±289.3	72.2 ±14.1	31.2± 17.8

Table 8: Carbohydrates consumed v/s recommendation.

One of the main causes of the deficit in the intake are GI discomfort [22,23,26,35,38,39]. Another reason is the difficulty of charging foods and drinks [27] either by the topographical and/or climatic characteristics, or the weight of the food. All this leads to a reduction in the amount of available HCO of easy assimilation. Specifically, Brown et al. distinguished women who met HCO requirements due to their lower energy consumption.

Another important point is the relationship between the speed of the runner and the rate of intake of HCO. Glace et al. refers to the intensity of the workout and as this influences the amount and type of food that will be ingested. In his article the average speed was 5.6 km/h in the second half while those who ran 100 km reached 10 km/h. In this sense, Costa et al. sets that intestinal adaptation is particularly beneficial for faster runners, since by its volume of training they would be more accustomed to the kind of power [28].

Proteins

Several articles provided no data on protein intake [22,23,26,35,38,39]. The rest of the articles provides mainly grams total intake and a few added the % representing (Table 5).

Note: there are no recommendations for continuous ultramarathons. Those analyzed by the study of Stuempfle.

The intake is located below the recommendations proposed by [31] and ACSM (2016). In the study of Fallon et al. whereas the range 1.2 - 1.7 g/kg for the subject with 77.2 kg, intake should be located around 108.08-131.24 g, but the total represents 13 g total, if we consider the ratio g/kg BM/h, that should be in 61,06. The recommendations are not fulfilled in any study.

Stuempfle et al. observed that the ratio of consumed proteins which ended and did not were not different. The average ratio of those who finished (0.08 g/kg/h) Stuempfle et al. was similar to that observed among those who ended up in the Vermont 100 Mile Endurance Run (0.07 g/kgBM/h). In the neither article of Wardenaar et al. nor women reached to cover recommendations. In another study Martinez et al. the rate is 0.04 ± 0.03 g/kg BM/h, at half of the aforementioned reference [34,35].

Fat

Multi-day events is relevant to increase the amount of fat in the diet because of the impossibility of replecionar glycogen (HCO implies lower energy input) [2]. If we consider the UM you continue (Table 6), not all items provided this information. Total grams are from 97.1 grams for the group of men [39] up to 1.1 grams [35]. As a result the % reflect these intakes located in a maximum of 32.1 in the group of women [39] to a minimum of 0 [35].

If we consider the recommendation for the UM, earlier described intakes are different, many of them do not reach even half of it [22,30]. Two studies are characterized by their percentage of intake [38,39] where the percentages are among the 21 ranges, 4-32%. In these cases there was an outstanding participation of fats in the intakes of the athletes.

Hydration

The analysis of this section shall be regarded as the positioning of the ACSM (2007), which highlights the importance of preventing dehydration. The amount and rate of fluid replacement depends on the rate of sweating; this information is provided in this review an article [26] (0.86 l/h). The sweating rate ranged between ~0.4 and ~1.8 l / h. Applegate et al. refers to the consumption of fluids and energy during the competition of endurance as essential to control body temperature. It proposes an intake of 150-250 ml every 15-20 minutes [12].

Hydration strategies must be individual [28] there are benchmarks: ACSM (2007 & 2016) established between 400-800 ml/h or 500 - 2000 ml/h [14]. In the case of the revision, whereas articles that provided the ratio ml/h, [28] group of the slow, [35] which did not finish the UM, Wardenaar et al. and Martinez et al. did not meet recommendations, while [22,23,26,35,38,39] group of the rapids was between the appropriate limits.

With regard to the type of drink, for [28] 62% was water and the rest came from other sources, such as soft drinks (47%), milk (38%), fruit juices (16%), mixtures of HCO and protein (16%). In the same article found 11% of athletes who consumed only water in the entirety of the event. Costa et al. found no difference between the genders. In others, the fluid intake provided by wet sources represented 16% of the total of the same [28,31]. The fastest Group had a higher intake of water observed by the slow, while this relationship was in the article of [31] with respect to which completed and did not.

Weight change, Hoffman et al. found there were no variations between those who completed and those who do not. In that article the athletes had a loss exceeding 2% of the MC. It is important to note also that many of those who managed to finish before had losses greater than 2% and even held the loss over the course of the event [35]. Similarly, in the article of [31] significant differences between the two groups there was - 0.5 ± 1.5 kg *vs.* -1.2 ± 1.8 kg ($p=0.27$); nor did in the fat body pre to post-event (12.8 ± 6.1% *vs.* 11.9 ± 3.7%, p = 0.29). For modification of weight is not a relevant factor among those who completed and those who did not moreover does not necessarily have adverse consequences in UM events with heat stress performance. Stuempfle et al. also highlights the lack of difference compared to the weight change between which ended and those who did not [35]. In that article the weight difference was close to 3%. On the contrary, others suggest [41,42] that there is a relationship between the finish of the race time and change in body weight, due to the increased speed, which leads to a greater loss of sweat [42].

Wardenaar et al. for weather and organizational issues could weigh no runners at the time of intake of fluids, making it difficult to draw conclusions regarding the water balance and whether it was adequate [30].

Considering the UM performed in laboratory Moir et al. weight loss also remained around 4%, demonstrating the difficulty of maintaining the MC even under more controlled conditions [37].

It is important to highlight the conclusions presented by Winger et al. regarding beliefs and motivations that influence the making of hydration plans. It was observed that you determine beliefs moved to intake planning particularly in inexperienced athletes (Figure 4).

Sodium

In the revision of article Stuempfle et al. which ended the event consumed 17.9 g of sodium compared with those who did not that consumed 6.2 g [35]. The ratio of consumption is around 10.2 ± 6.0 mg/kg/h and for which ended 5.2 ± 3.0 mg/kg/h. In the article of Glace et al. runners ate sodium at a speed of 0.5 g / h, much less than the 1-2 g of sodium per hour recommended for athletes from UM [28]. Glace et al. reported a sodium intake of 16.4 ± 6.8 g, with a range from 4.9 to 27.5 g. They were consumed, at speeds of 0.7 l/h and 0.6 g/h, respectively [31].

Limiting main intake in Ultramarathon

Several authors [23,28,31,39] suggest that failure to comply with the recommendations is possibly by GI discomfort and / or the Suppression of appetite [28].

Stuempfle et al. found no significant differences in rates of consumption and intake of drinks among those who had symptoms and those who do not. On the contrary in other articles [31,23] athletes who expressed discomfort coincided with the increased intake of HCO; with respect to other nutrients maintained a similarity in the intake rate. In those articles was found a significant relationship between the DSH and GI symptoms. Such discomfort would it be related to metabolic changes caused by stress or changes in the integrity of the mucosa by ingested food [23]. Despite this, the discomfort decreased in trained athletes [23]. A possible explanation for the differences found between [23] and [30] is the type of questionnaire presented to athletes. In the first case it had to choose between whether there were or not the presence of the symptoms; while in the second case the questionnaire typified the symptomatology. Hence, if it found a correlation moderate between nutrients and symptoms; higher intake of nutrients minor symptoms. It is not clear if this is due to fewer symptoms which leads to an increase in intake. In addition, there was no difference between genders [28,42-58].

Conclusions

i. The UM are events ranging from 6 to 24 days or more. Not only the prolonged duration of the same but the multiplicities of geographic conditions and /or weather to these events confer a special difficulty to complete nutritional strategy raised previously.

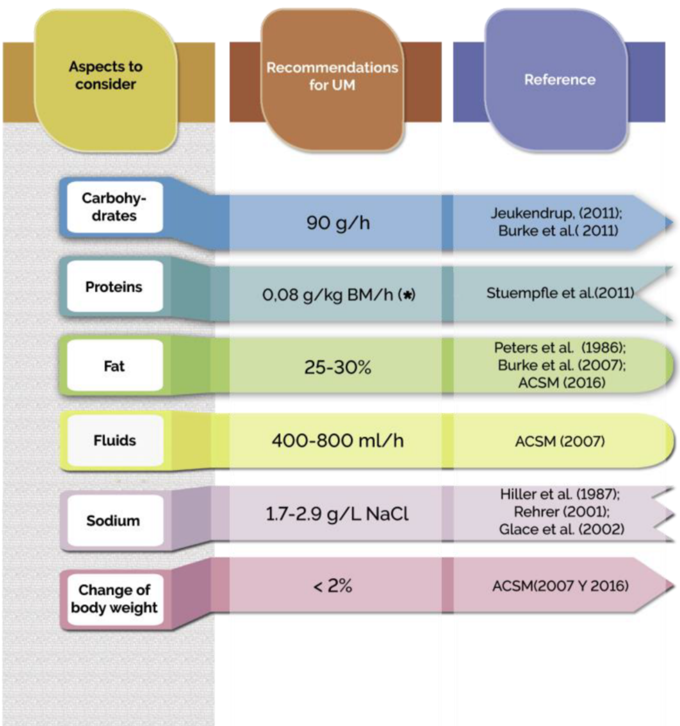

Figure 4: UM nutritional guidelines.

Citation: Arribalzaga MS, Ruano MAG, Sáiz SLJ (2017) Review of the Food Guidelines in Continuous Ultramarathon. J Nutr Food Sci 7: 635. doi: 10.4172/2155-9600.1000635

Reference	Sample	Type of studies	Study of Variables	Event/ Distance	Weather conditions	Duration	Calories	Hidrata-tyon	GI	Conclutions
Newmark, Toppo, Adams. 1991	3 M	Observatio-nal	Sample of blood, intake of fluids and electrolytes. Renal function, albumin, calcium, phosphorus and magnesium	1. Western States Endurance Run, in, Nevada, (100 km) 2. Leadville Ultrama rath in, Colorado, (62 millas) 3. Wasatch Ultrama-rathon in , Idaho, (160 km)	0° a 43.3°C	24 h	1038- 4015 kcal	a.12.1l b. 4.6 c. 22.4l (comple-ted)		It is possible to maintain normal states of hydration and electrolytes during a long career, provided that adequate fluid and electrolyte solutions are eaten. Runners consumed the solution without medical complications and kept the previous BM and endocrine parameters / metabolic normal.
Fallon et al. 1998	10 M 3 excluded (injury km 40, inadequate information)	Case study	Body weight; analytical (HCT, hb, glucose, glycerol, free fatty acids); rate of sweating, diet analysis	100 km	2°C-17°C Humidity: 45% Wind Speed: 7 km/h	10 h:48 min (media)	4233kj /1011 kcal	5.7 l	Yes	HCO and average fluid intake were within the recommendations No significant correlations between the absolute amounts and rates of ingestion of HCO, fluids and performance A low total fluid intake was associated with the reduction of the stroke rate in the last 25 km of the event. Ideal half of HCO in liquid form to achieve the recommendation.
Glace, Murphy y McHuhg. 2002a	26 23 completed 88 km	Observatio-nal	Rate of intake of fluids in which culminated.	160 km y 88 km	21°C-38°C	Completed race: 26,2 ± 0,4 h. Not	21589 ± 12803 Competed:	0.7 l/h	Yes	Rate of intake of fluids in which culminated.
	13 completed		Adequate intake of fluids to maintain the body weight.			completed n: only 45 km	29493 ± 3481		(17 de 26)	Adequate intake of fluids to maintain the body weight.
Glace, Murphy y McHugh. 2002b	19 (4: not completed)	Observatio-nal	Nutrition questionnaire, discomfort GI, mental status changes	160 km		24,2 (±0.67) h	6047 kcal	18 L	Yes	After 88 km, higher prevalence of upper GI symptoms Very high intake of foods or liquids seems to lead to a disturbed mental state.
Clark, Barker y Corfe. 2005	90 (84% M) Short:45 Medium: 25 Large: 15	Observatio-nal	Inventory of food and fluids Anthropometric characteristics	4 ultramara-thons in United Kingdom (2003)	Summer and Autumn	36 h	20.61 kj/kg/h	< 0.5 l/h		Older athletes consumed less HCO. 77% of products derived from sports drinks or dehydrated food. Most competitive athletes can tolerate the severe DSH
Moran Dziedzic y Cox. 2011	1	Case Study	Registration of food during event UM (HCO, fluids, sodium)	The North Face 100 Blue Mountain in New South Wales, Australia	3.8°C-15.4°C	12:48:55	2692.7 cal (736kj/h)	6150 ml (415 ml/h)	No	Events with a duration of 6 to 8 h should ensure adequate intake of electrolytes, primarily sodium Avoid flavor fatigue. Training of the nutritional strategy to be used in the race
Stuempfle, Hoffman, Rogers & Wescher.2011	16 6 completaron (4 h, 2M)	Observation al	Peso, altura, IMC, registro alimentos y fluidos.	Western States Endurance Run 161 km (2009)	4°C-37°C	Terminaron 27,0 ± 2,3 horas No terminaron: 96,5 ± 20,5 km en 17,0 ± 3,9 h	Finalizaron: 8228.3 ± 2377.0 kcal No finalizaron 3106.3 ± 1545.3 kcal	Comple ted: 19.8 ± 6.8l Not comple Ted: 10.8 ± 5.2l	Yes	Those who finished the race consumed fluid, HCO, and sodium at a rate >; from the first tranche. Low power consumption which is not finished
Costa, Gill, Hankey, Wright y Marczak.2014	48 they volunteered UER: 25	Observa-tional	Sample of urine, blood, body weight	Glenmore 24 Trail Race (2011-2012)/	2011: 0°-20.8°C 2012: 3°-	24 h	UER: 20 MJ	3·2 to 16·2l	Yes 65%	Include: dietary strategies for the event. HCO loading protocol in the days before
	CON: 17			Cairngorns National Park Scottish 122- 208 km	19.8°C Humidity: 54-82%					Bowel training. Quality and proper amount of hydration.
Brown. 2015	4 M A: 39-54 years	Case study	Energy and fluids consumed energy spent, body weight.	The Badwater UM Death Valley, USA 217 km (2012)	36.6°C - 46.6°C	34:05:25-40:51:46	8036 cal	33.8 L		The subjects completed the race despite the caloric deficit and loss of body mass. Maintain a proper balance between hydration and food to complete successfully.
Wardenaar 2015	Daily records 120 km: 1 F 7 M 60m km: 12 F 48 M Questiomna rie post race : 60 km : 8 F 33 M Observation al in race_12º km 4 M	1.Intake daily 2 months pre race 2. Questionnai re intake the day of the race, and GI upset 3.Obsevatio nal for 120 km	Record food 24 h, questionnaire with: type of training, amount of exercise, perception of effort, ingest food, sports supplements.	Island of Texel, Holand 60-120 km (2013)	2.2 °C- Humidity: 77% Wind Speed: 6.1 m/s	120 km 9:30:3-11:59:24	60 KM: E: 4.9±2.3MJ 120 km: E: 1.45-5.51 MJ	60 KM: 21.4 L 120 km: >350 ml/h	Yes	60 km: Intake of less than hour recommendation HCO 120 km: Ingestas high of HCO 60-90 g/h 82% reported discomfort GI > nutrient intake linked to less GI symptoms
Stellingwerff 2016	3 M	Case Study	Questionnaire on the intake during the event, body	1.WSER Sierra Nevada (2014) 2. Hardrock 100 miler, San Juan (2014) 3. 100 km	1.0°C-31,7°C (5513 m) 2. 8°C-22°C (3400m)	1. 14 9:00 2.Sin dato 3: 6:27:43 1800	5530±1673 kcal			3 runners practiced nutritional strategies to improve the bioavailability of HCO during the race. Consumption of ginger for prevention of nausea, vomiting (GI symptoms), and caffeine.
			weight	World Cham-pionships in Doha, Qatar	3. 25-27°C Humidity: 60%					Predominance of oxidation of HCO (on the winner).
Martinez et al. 2017	Marathon: 51 Trail: 109 Ultra: 53	Observa-tional	Nutrition questionnaire (intake during the event). MC, height, age	2015 Ultra Mallorca Serra de Tramuntana	11- 21° C Humidity relative: 40–98%	Consum ption of energy and fluids during the event.	183 kcal/h 3041 ± 1594 (total)	6319 ± 4214 ml		Low intake of HCO in general, but higher in those who completed; > consumption of lipids in the corridors of UM. There are no differences in the nutritional strategies depending on the distance.

Annex 1A: Summary table articles.

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ii. They are not reached to cover the hydric or nutritional recommendations.

iii. Two points stand out; the difficulty of loading all food or supplements required and the persistence of GI symptoms and/or appetite suppression.

iv. The age of higher performance in corridors of UM comprises between 30 to 49 years in the men and for women between 30 to 54 years. Powers of 161 km 80% are men. In relation to the previous experience, runners finished at least 34 ± 73 marathons previously; with previous experience in UM's 7.6 ± 6.3 years.

v. Continuous Ultramarathon runners have made higher volume training (80-173 km per week) in relation to other studies whose objectives were to describe the type of training (85.0 ± 35.8 km/week).

vi. Inadequate hydration in these events and in particular at those who perform in warm environments not only contributes to the abandonment of the event but also to a decrease in performance or implications on the health of the athlete.

vii. Several factors are responsible for the performance at UM events in mountain (previous experience, level of training, environmental conditions, orientation). It is these circumstances which determine that athletes of this specialization can mostly do not cover nutritional recommendations.

Practical Applications

Suggest a proper food education to athletes of Ultramarathon, which consider environmental and topographic conditions of the event. Propose strategies to optimize: the ingestion of HCO prior and during the event, bowel training and management of the intake in the lack of appetite, amount and type of hydration (Annex 1A and 1B) (Figure 4).

Future Research

Future research should address the problems linked to the non-compliance of the recommendations particularly when environmental or geographical conditions present greater difficulty. In relation to the data collection Protocol, it would be expedient search and offer alternatives to the moment of the collection due to the difficulty to access the checkpoints by the research team. Future research should unify some protocols to facilitate subsequent analysis.

Limitations of this Review

One of the main limitations occurred setting a paucity of studies that address the dietary guidelines in UM. These studies point out a topic exclusively; hydration or only intake of HCO. The study is has been able to address with the desired depth due to the differences in samples, tests and types of studies, increasing the difficulty of the synthesis and review of the subject of study.

Reference	Sample	Type of studies	Study of Variables	Event/ Distance	Weather conditions	Duration	Calories	Hidrata-tion	GI	Conclutions
Hoffman y Stuempfle.2014	383 277 completed	Observational	Weight body questionnaire: strategies of hydration, intake of sodium, consumed foods	Western States Enduran-ce Run 161 km Sierra Nevada (2013)	5°C (al inicio/ - 39°C Humidity: 18-38% Speed of Wind: 15 km/h	30 h		20.6% had BM > 4% (dehydration), 50.2% had BM of >; 1% to 4% (euhydration) and 29.2% had gain or loss of weight ≤1% (overhydration) at the end		Weight loss > 2% do not have adverse consequences. The use of supplements sodium or drink beyond thirst is not necessary to maintain hydration in events with thermal stress. Relationship between weight loss and the time of completion of the event.
Taylor, Stuempfle, Kern y Hoffman.2015	30 (20 completed)	Observational	Body and weight (3 times during the event and at the end)	Western States Enduran-ce Run/ 161 km (2014)	17°C a 39°C	30 h				In warm environments, runners can tolerate corporal major losses 3%, not associated with the increase of the temperature core. Fluid replacement is not preventive for heat-related illnesses. Faster runners are those who lost more MC
										(weight loss >: 3% for 3. 5 - 4% of runners)
Hoffman, Khodaee, Spittler y Van Baak.2015	a.658 b. 518 c. 344 d. 70(51 completed) e. 84	Observational	a BM pre event b. BM during c.BM at the end d. urinary analysis: 70 e. samples of blood 84 (66 ended)	WSER Run/ 161 km		30 h				Fluctuations in the peso(-2.1%), weak variable to predict performance. It requires further study to determine their correlation

Annex 1B: Summary table articles.

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